Codes and Standards Enhancement Initiative
For PY2004: Title 20 Standards Development

Analysis of Standards Options For Consumer Electronics Standby Losses

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September 10, 2004

This report was prepared by Pacific Gas and Electric Company and funded by California utility customers under the auspices of the California Public Utilities Commission

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1 Introduction

The Pacific Gas and Electric Company (PG&E) Codes and Standards Enhancement (CASE) Initiative Project seeks to address energy efficiency opportunities through development of new and updated Title 20 standards. Individual reports document information and data helpful to the California Energy Commission (CEC) and other stakeholders in the development of these new and updated standards. The objective of this project is to develop CASE Reports that provide comprehensive technical, economic, market, and infrastructure information on each of the potential appliance standards. This CASE report covers standards and options for consumer electronics including audio, video, and set-top box products.

2 Product Description

The term consumer electronics covers a wide variety of products from the smallest portable CD player to the largest projection TV set. This CASE report covers audio, video, and set-top box products that run off of mains power and use an internal power supply (appliance standards for products using external power supplies are addressed in a separate CASE study). Audio, video, and set-top box products are unique because their energy use in their low power modes ("lopomo") is significant, and typically constitute the majority of their total annual energy use. Each of these classes of products includes a wide and ever increasing range of appliances, often identified by an alphabet soup of acronyms. Table 1 lists some of the more common acronyms, followed by a description of the categories.

Table 1: Common Consumer Electronics Acronyms

Acronym	Term	Comment
DBS	Direct Broadcast Satellite	Television broadcast from a satellite directly to a home receiving dish
DTH	Direct-To-Home	Another term for DBS
DTA	Digital Television Adapter	Converts digital TV signals for use by legacy analog equipment
DTC	Digital Television Converter	Another term for a DTA
DTV	Digital Television	A television signal encoded using digital rather than analog techniques
DVD	Digital Versatile Disk	
DVR	Digital Video Recorder	Records a video signal on a hard disk for time-shifting and later playback
EPG	Electronic Program Guide	Electronic schedule displayed on a TV
HDTV	High Definition TV	Digital TV with a wider, higher resolution picture
IPTV	Internet Protocol TV	Video signals transmitted over a broadband connection
IRD	Integrated Receiver Decoder	Cable or Satellite STB
OTA	Over-the-Air	Standard broadcast TV, also known as Terrestrial
PVR	Personal Video Recorder	Another term for a DVR
STB	Set-top Box	Video signal conversion/decoding device
VCR	Video Cassette Recorder	Records a video signal on video tape
VOD	Video On Demand	Use of two-way communication to select personal content

Audio Products

This category includes the compact audio and portable audio subcategories and also contains component products such as CD players, tape players, equalizers, and stereo receivers. Compact audio systems refer to integrated audio systems consisting of an amplifier and speakers with one or more functions including but not limited to a radio tuner, tape player, CD player, and MP3 player. They are also known as a mini, mid, micro, or shelf audio systems.

Video Products

This category includes televisions, video cassette recorders (VCRs), digital versatile disk players and recorders (DVDs), and digital video recorders (DVRs), also known as personal video recorders.

Set-top Boxes

A set-top box (STB) is generally defined as any product that converts a video signal for display on a TV screen. This includes two major subcategories that are not always clearly distinct: Integrated receiver decoders (IRDs) and converter boxes. IRDs, such as analog and digital cable boxes, and satellite receivers, as the name implies, receive and decode signals from either cable or satellite providers for use by TVs and VCRs. Converter boxes, such as digital television adapters (DTA) and high definition television (HDTV) conversion boxes convert digital television signals to a composite video signal used by standard analog televisions. STBs can also be categorized by signal source and complexity. The four most common signal sources are: Terrestrial (also known as Over-The-Air (OTA)), Cable, Satellite (also known as Direct to Home (DTH)), and the newest, IP (internet protocol) or broadband. We define two classes of complexity: basic and advanced. A basic STB either decodes or converts signals from a terrestrial, cable, satellite, or IP source for display on a TV. It does not contain a hard disk and it communicates in only one direction. An advanced STB adds one or more functions or services including digital recording, video on demand (VOD), video games, and interactive TV.

There is also a long and growing list of combination products, which have properties of two or more of the above categories such as a TV/DVD, a DVD/VCR, a TV with integrated IRD, or an IRD with DVR capabilities. Two recent product releases demonstrate the variety of product that has become available: Sony’s "PSX" is an entertainment system consisting of a satellite TV tuner and DVD recorder plus its PlayStation 2 game player, and Scientific Atlanta has recently released a digital cable box with DVR and video game capability.

3 Market Status

3.1 Market penetration and sales

The consumer electronics market is characterized by extremely fast technology change and very rapid market penetration. There are currently over 100 million audio, video, and STB products in California homes but sales and stock are changing rapidly.

3.1.1 Audio

There are 50 million audio products in California. Most audio product markets are fully mature but there is a trend in rack audio towards home theatre, which blurs the line between audio and video products. We were not able to obtain any data on the sales or stock of these new products and they are likely to be changing extremely rapidly. Table 2 summarizes stock and sales for more traditional audio products

Table 2: California Audio Products Stock and Sales

Product	*Saturation*	*Stock*	*Sales*
Amplifier		814,000	181,500
Cassette deck		3,839,765	1,045,000
CD player	57%	6,602,310	3,764,530
Compact audio system	49%	7,761,930	1,102,970
Personal stereo		7,700,000	3,080,660
Portable CD player		1,100,000	2,123,880
Portable stereo	68%	14,630,000	3,265,460
Stereo receiver		6,512,000	1,441,000
Tuner		814,000	116,270
TOTAL		49,774,005	16,121,270

Source: Stock and Sales (DOE 2002), Saturations (Appliance 2002)

3.1.2 Video

There are 40 million video products in California with an average of over two TVs in each household. Sales and stock of video products are summarized in Table 3. Television sales have been flat for many years, while DVD sales have been explosive (the fastest ever of any consumer product), and have now exceeded VCR sales, which continue to decline.

Table 3: California Video Products Stock and Sales

Product	*Saturation*	*Stock*	*Sales*
Analog color television	98%	18,686,000	2,328,000
LCD television	12%	1,390,000	47,000
Projection television	15%	1,737,000	161,000
TV/VCR combination	22%	2,699,000	551,000
Video cassette recorder	94%	11,305,000	1,640,000
DVD player	25%	3,086,000	1,554,000
Digital Video Recorder		385,000	145,000
TOTAL		39,288,000	6,426,000

Source: Stock and Sales (DOE 2002), Saturations (Appliance 2002), DVR (ABI 2004)

The Federal Communications Commission (FCC) has mandated that all analog commercial TV broadcasts will stop as of January 1, 2007 or when 85 percent of all homes with televisions are capable of receiving digital TV (DTV), whichever comes first. This deadline is likely to slip but probably not past 2009 due to pressure from both industry and the FCC (Weaver 2004). Once analog broadcasting has stopped, the FCC can then reclaim the 700 MHz band from broadcasters and turn around and sell it to

wireless carriers for advanced services, potentially raising billions. This broadcast conversion is the largest transition since the conversion from black and white to color.

To ensure that TV tuners are ready for the digital conversion the FCC is requiring manufacturers to start including DTV tuners in a fraction of all new TV sets starting in July 2004 with large screens and incrementally moving to smaller sets through July 2007.

Digital Video Recorders (DVR) are a new product that records video on a hard disk rather than magnetic or optical media. This allows the device to also provide features such as pausing and rewinding of live video and time shifting of programs. TiVo is the largest manufacturer and has annual U.S. sales of 1.3 million and also licenses their technology to EchoStar's Dish Network. Recently other cable and satellite box manufacturers have started to include their own DVR technology in their equipment. Altogether we estimate that there are 3.5 million units nationally with at least 170,000 in California. Despite high user fees, research firm International Data Corp estimates there will be 25 million nationally by 2006[1].

TV's too are undergoing a transformation, with the line between TV and PC becoming blurred. The large traditional PC manufacturers such as Dell, Gateway, and HP see the consumer electronics area as an opportunity for significant growth and are developing lines of consumer electronics devices. This is being encouraged by such developments as Microsoft's Media Center operating system and Intel's integration initiative, all designed to allow a PC to perform multimedia functions.

To many, Digital TV (DTV) is synonymous with HDTV, but DTV refers to the transmittal format and HDTV refers to the screen resolution. HDTV requires DTV but DTV can be displayed as either Standard Definition TV (SDTV) or HDTV. Most digital TVs sold today are "HDTV-ready" (or the equivalent term "HDTV monitor"), meaning that the TV can display HDTV content, but it does not have an HDTV tuner/decoder built-in, and that it will require a STB to display a terrestrial HDTV signal. Some cable companies are now supplying digital cable set top boxes with HDTV decoding functions built-in, and they usually charge a premium for HDTV service[2].

3.1.3 Set-top Box

There are 9 million STBs in California, almost all either cable or satellite IRDs. This market is also changing rapidly as cable systems convert to digital and HDTV sources and cable and DTH providers battle it out for customers. Current sales and stock of STBs are summarized in Table 4.

Table 4: California Set-top Box Stock and Sales

Product	Stock	Sales
Analog cable box	1,320,000	100,000
Digital cable box	4,400,000	916,000
Satellite receiver	3,234,000	550,000
TOTAL	8,954,000	3,080,000

[1] http://story.news.yahoo.com/news?tmpl=story&u=/nm/20030418/tc_nm/column_pluggedinscheduledweeklycol_dc_1

[2] http://www.extremetech.com/article2/0,3973,890601,00.asp

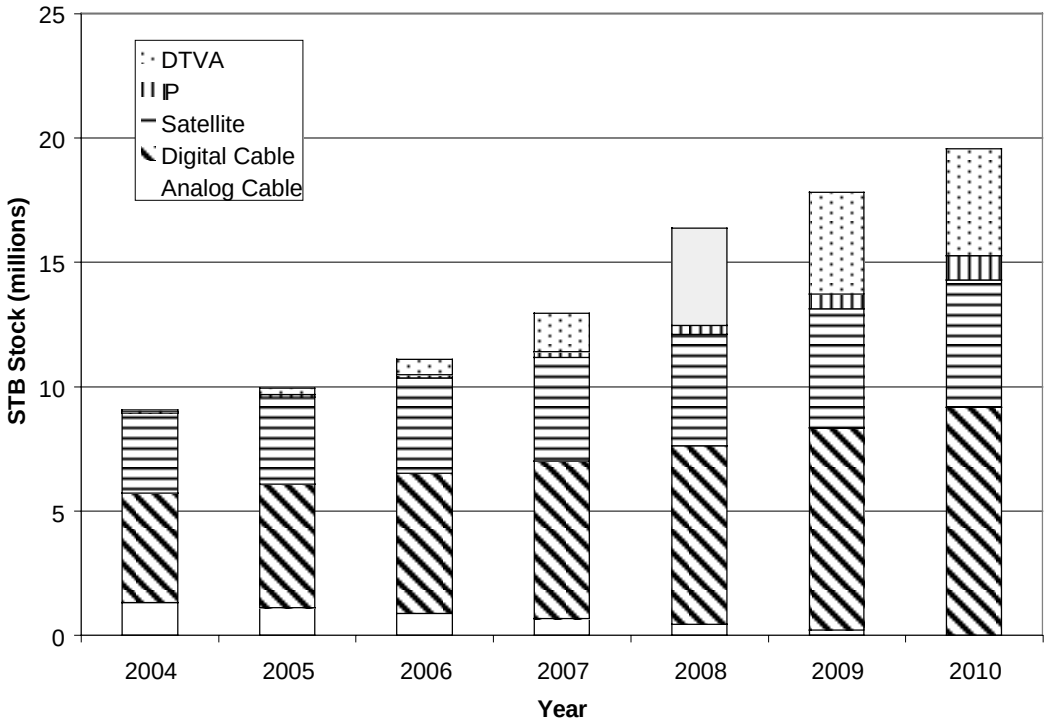
Source: Instat/MDR, ABI

Three recent FCC decisions affect STBs and make prediction of future sales very difficult. First is the conversion to digital terrestrial TV broadcasting, which will require all those who want to receive terrestrial broadcasts on legacy analog equipment to purchase a digital adapter. Sales of low cost solutions such as retail bubble packs are expected be a major source of STB growth in the next decade.

Second, the FCC voted in 1999 to allow cable TV customers to buy standalone cable boxes, TVs, VCRs, and other devices with built-in decoders from retail stores, rather than rent them from their cable provider. Cable providers will still control critical security features through the use of a Point of Deployment (POD) card (also known as a CableCARD). However, to help create a retail market for the new set-top devices, the FCC rule bars cable operators from selling or leasing cable boxes with security built into them after July 2006. Currently, cable customers who don't have cable-ready TV sets must rent a set-top box for between $2 to $4 per month.

Finally, in September 2003 the FCC adopted new TV-cable compatibility rules that make it easier for new digital TV receivers to hook up to cable systems. This “plug-and-play” rule will allow consumers to plug their cable directly into new TV sets, eliminating the need for a dedicated STB to convert the signal. These integrated TV sets may reduce the need for basic STBs but are not expected to significantly impact STB sales until a second “two-way” plug-and-play rule is developed, which will allow for features such as video-on-demand and interactive TV.

Figure 1: California STB Growth, 2004 - 2010



In Figure 1 we provide our best estimate of the growth in California STB stock over the next six years. Analog cable boxes continue to be replaced by digital with modest growth in the total number of cable boxes. Satellite boxes continue steady growth and IP boxes start to increase substantially. DTV adapters experience major growth in 2007 and 2008 driven by the terrestrial DTV conversion, eventually reaching 20% of TVs, but then flatten out as legacy analog TVs are replaced. Total STB stock reaches just under 20 million by 2010. In addition to the growth in STB stock there will be an increase in the use of advanced features as basic STB functions are usurped by integrated TVs and STB manufacturers look to maintain high margins.

3.2 Market penetration of high efficiency options

Both the U.S. Environmental Protection Agency (EPA) and the Federal Energy Management Program (FEMP) publish lists of products that meet their guidelines. Comparing the lists shows that they are almost identical indicating that manufacturers are taking advantage of the similarities in the guideline levels. Over 2500 products are currently listed in the data bases. The EPA data is summarized in Figure 2. Table 5 summarizes the current and predicted penetration of Energy Star products into various consumer electronic categories. While VCRs are almost universally Energy Star rated, and more than half of DVDs are, less than half of audio products are listed and very few Energy Star rated set top boxes are available.

Figure 2: Summary of Energy Star Listed Products

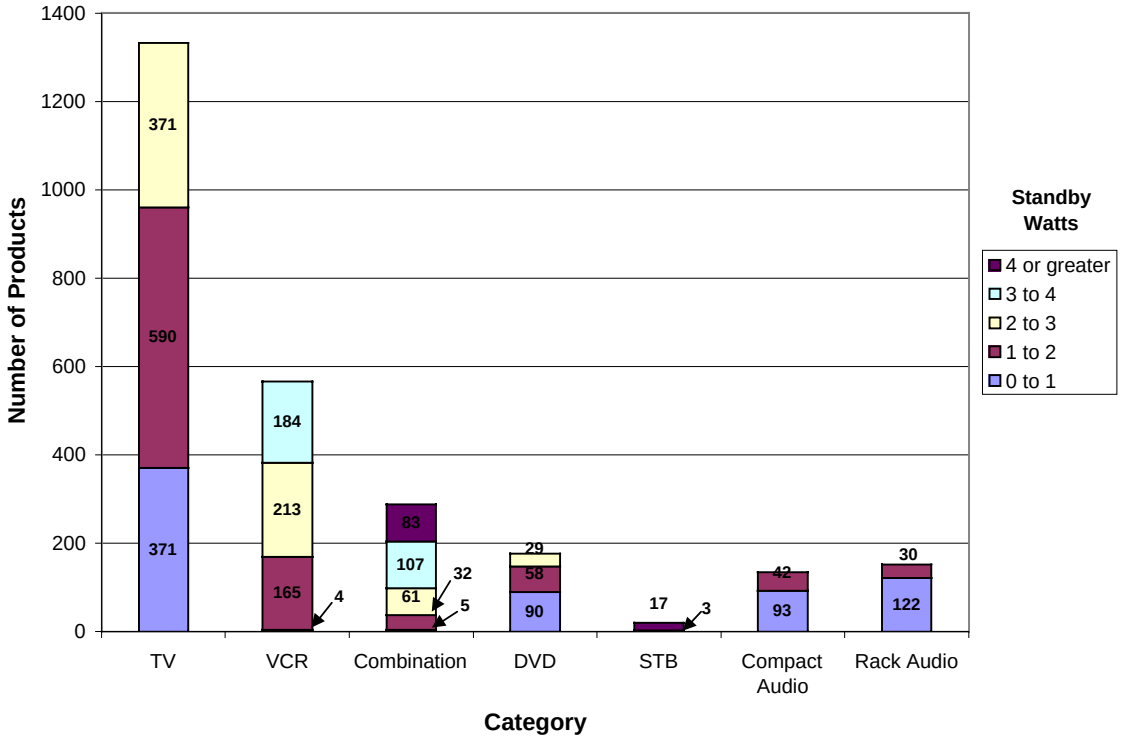


Table 5: Percent of Products Having Energy Star Feature

Product	*2001*	*2003*	*2005*
TV	49%	58%	58%
VCR	90%	90%	90%
TV/VCR	77%	80%	80%
DVD	26%	59%	64%
CD	25%	38%	38%
Audio	21%	44%	49%

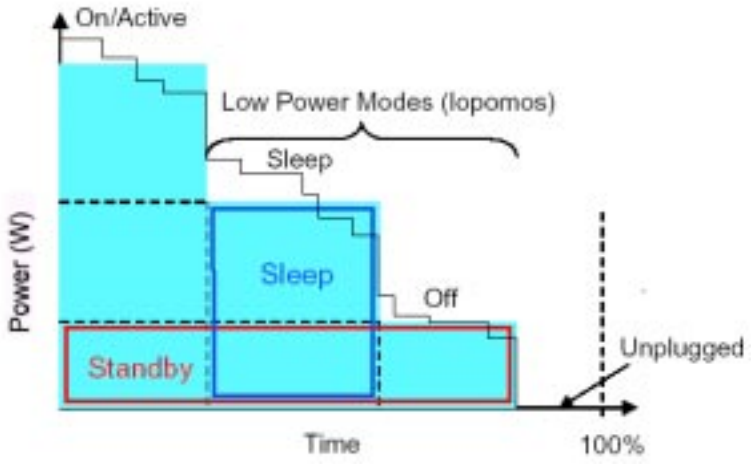
Source: CCAP

4 Savings Potential

4.1 Baseline energy use

Historically, most electric equipment operated in two modes – on and off. All that was required to calculate annual energy use was a measurement of on power and an estimate of on-time. With the advent of intelligent products controlled by microprocessors, that has all changed. Consumer electronics now have several modes of operation (see Figure 3). Most Audio and Video equipment have three main modes of operation: the on or active mode where the devices is performing its main function (the TV is displaying a picture, the VCR is playing a tape), the standby-mode where the equipment is powered but not performing its main function (the TV is waiting for a remote control signal to be turned on, the VCR is waiting to record a program) and the off-mode when the device will not respond to the remote (often only when the device is unplugged). Set-top boxes can have many more modes, which can usually be characterized into four categories: the on or active mode when a video signal is being converted and passed to the display or recording device, the active standby mode when the device is communicating with the service provider in order to download programming information, the passive standby mode when the device is waiting for a signal from the remote or an internal signal, and the off-mode when the device will not respond to external or internal signals.

Figure 3: Modes of Operation



Source: Alan Meier, LBNL.

Table 6 lists average standby power levels, hours of operation, and resulting standby energy use for 20 products from a DOE report which collected data from a wide variety of sources in order to develop a database of standby energy use (DOE 2002). DTA and IP STBs are so new that there is very little data on their energy use in the literature. DTA data was obtained from measurements of four British terrestrial DTAs from the EPIC database (EPIC 2004) and eighteen measured by the Australian Greenhouse Office (NAEEEC 2004). No data was found for IP STB power use and so we used our best estimate based on power use from similar devices.

Table 6: Consumer Electronics Standby Operation

Product	*Power (W)*	*Hours (per year)*	*Standby Energy Use (kWh/yr)*
Audio			
Amplifier	1.1	5694	6.3
Cassette deck	1.6	5694	9.1
CD player	1.8	5694	10.2
Compact audio system	9.8	6570	64.4
Personal stereo	2.9	3241	9.4
Portable CD player	2.9	4468	13.0
Portable stereo	1.8	4467	8.0
Stereo receiver	1.8	5694	10.2
Tuner	1.5	5694	8.5
Stock Weighted Average	**3.2**		**17.8**
Video			
Television color analog	7.3	6205	45.3
Television LCD	4.2	6205	26.1
Television projection	4.2	6205	26.1
TV/VCR combination	7.6	6205	47.2
Video cassette recorder	6	8552	51.3
DVD player	4.2	6307	26.5
Digital video recorder	18	8552	111.7
Stock Weighted Average	**6.9**		**45.6**
STB			
Analog cable box	11	6205	68.3
Digital cable box	23	6205	142.7
Satellite receiver	16	6205	99.3
DTV Adapter	8	6205	46.5
IP	14	6205	86.9
Stock Weighted Average	**16.4**		**101.7**

4.2 Proposed test method

EPA has developed a number of *ad hoc* test methods for its various Energy Star product specifications, the details of which tend to vary from product to product. The European Association of Consumer Electronics Manufacturers (EACEM) has published a draft standard prEN50301 *Methods of Measurement for the Power Consumption of Audio,*

Video and Related Equipment[3]. It defines equipment, six operating modes and a measurement procedure.

In November 2003 the International Electrotechnical Commission (IEC) TC59, Working Group 9 published the Committee Draft for Vote (CDV) of IEC 62301 – *Household Electrical Appliances - Measurement of Standby Power* (IEC 2003). It draws from prEN50301 but is designed to address a wider range of products including white goods. It defines standby energy use as:

> *The non-operational, lowest power consumption mode which cannot be switched off (influenced) by the user.*

It specifies two measurement methods: one for products with stable lopomo and another one for products that exhibit changing modes. It recommends the later if there is any doubt as to whether the operation mode is stable:

> *This methodology shall be used where either the mode or measured power is not stable. However, it may also be used for all stable modes and is the recommended approach if there is any doubt regarding the behavior of the appliance or stability of the mode. Average power readings or accumulated energy over a user selected period are used in this case.*

FEMP has developed a Draft Interim Test Procedure based on IEC 62301 and FEMP intends to keep its test procedure consistent with the final IEC test standard. It is also likely that EPA will begin to reference IEC 62301 in their Energy Star specifications.

The CDV has been approved and is currently being translated into French. A Final Draft International Standard (FDIS) of IEC 62301 will be issued for voting before October 20th and final publication is expected by March 2005 (Harrington 2004). Contingent on the final publication, we recommend that IEC 62301 be specified as the test method required for measuring standby energy use of all consumer electronic products. Another option is to specify Australian standard AS/NZS 62301(Int):2003, an interim standard identical to IEC 62301 that will expire in September 2005.

For measuring the power use of consumer electronics in modes other than standby the appropriate test method is IEC 62087:2002(E), *Methods of measurement for the power consumption of audio, video and related equipment*, 2002-03. It includes definitions of equipment and operating modes, a general method of measurement, and detailed measuring conditions for TVs, video recording equipment, STBs, audio equipment, and multi-function equipment.

4.3 Efficiency measures

For most audio and video products that have a single passive standby mode lowering standby energy use is straightforward. Power supply design accounts for most excess energy use and numerous electronic component manufacturers such as Power Integrations, TI, and ON Semiconductor, offer low standby power development kits. For example, Power Integrations' TinySwitch-II IC is used in many consumer electronics

[3] http://energyefficiency.jrc.cec.eu.int/pdf/TR-036-r01_Audio_VA.pdf

power supplies to keep standby power below one watt when in standby mode[4]. Using these techniques often reduces final component count and can even reduce production cost once design costs are accounted for.

Reducing the energy use of set-top boxes and other products with multiple complex operating modes is more problematic. Although the improved power supply measures mentioned above can be implemented and will be effective in passive standby mode, significant energy savings in the active standby modes seen in STBs must be obtained through three other avenues: Specification of efficient components, software control of subsections, and development of power-aware network protocols.

4.3.1 Efficient Components

Energy efficient components that can reduce energy use in both standby and active modes include flash memory or SRAM, LCD displays, low power data receivers and tuners, and monolithic ICs that incorporate subsections such as tuners and decoders into one device. Use of these components will increase first costs marginally.

4.3.2 Software Control

Using software to turn off sections of the circuitry that are not needed during a particular operating mode is one of the most cost effective methods of reducing standby power as the only costs typically incurred are one-time design costs. Possible options include turning off the outputs and graphics processors when an image display is not needed, powering only those tuners in active use, using operating systems that provide power based on usage, and reducing the CPU clock speed during standby. The major problem encountered is the managing of the working blocks during the active/passive stand-by without a common agreement/protocol by service providers.

4.3.3 Network Protocols

The use of cable and satellite network protocols to allow STBs to drop into passive standby states when not needed can provide significant savings. For example, STBs that download enhanced program guide information can wake up periodically to update the information but spend most of the time in a sleep state. Or, the network interfaces on STBs can be made with enough intelligence to identify network communications that call for the device to be awake. Some of these methods require new features in network protocols, but others can be implemented with current specifications. An example of where this is needed is that of the DTA. This product can attain very low standby power levels, but research indicates that the majority of consumers will not switch them to standby mode, thereby negating any potential savings unless they can be designed to follow the state of the device they are feeding (MTP 2004).

4.4 Standards options

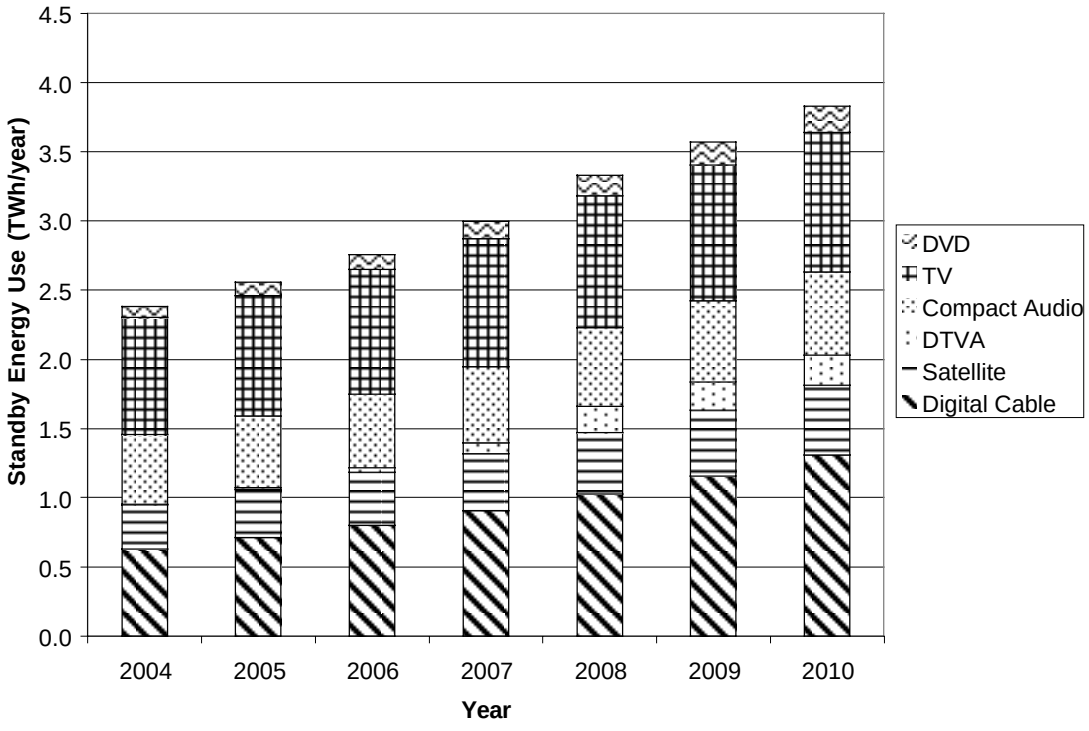
Of the consumer electronics products outlined above, some offer good opportunities for maximum standby power level standards and many do not. Some, like VCRs, already meet Energy Star levels for the most part. Others, such as portable audio, do not exhibit

[4] "Power Integrations Solution Chosen by China's Amoisonic To Provide Energy Savings in DVD Players" http://www.prnewswire.com/cgi-bin/stories.pl?ACCT=SVBIZINK3.story&STORY=/www/story/05-19-2003/0001949309&EDATE=MON+May+19+2003,+08:03+AM

significant energy savings because their average energy use is already so low. After reviewing savings opportunities for all the consumer electronics products we have chosen to focus on five with significant potential: TVs, DVDs, compact audio, basic IRDs, and DTV adapters.

TVs have a huge stock, most of which will have an accelerated turn-over in the next few years due to the digital conversion and many models are currently available that meet Energy Star levels. DVDs are just reaching the mature portion of their growth curve but many new versions such as DVD-R will keep sales strong. Similar to TVs, there are many models available, which meet Energy Star levels. Compact audio products stand out as the one audio product with significant standby energy use, even though efficiency measures are simple and inexpensive. Cable and satellite IRDs have standby energy levels almost the same as their on levels. Small changes in software control will allow them to meet standard levels. DTV adapters are poised for a huge growth spurt and provide the greatest opportunity for standards based energy savings. More advanced STBs are changing at such a rapid rate that they are not amenable to a standards based energy program, but should be addressed using network protocols. Figure 4 shows the estimated standby energy use for these five categories over the next six years.

Figure 4: Growth in Annual Standby Energy Use for 6 Products



There are many national and international initiatives that have voluntary or mandated levels of maximum standby power (see section 6.2). Energy Star Tier 1 is the most reasonable to adopt for a state mandated level for a number of reasons.

- It has been in existence for a relatively long time, allowing manufacturers to have familiarity with it.

- There are many products that already meet its levels.
- It covers a wide range of products, so that standard levels do not have to come from different sources.
- It is increasingly accepted on an international level as a basis for other programs.

The Tier 1 levels for STBs have also been used as a basis for standby power levels in the model state standard legislation developed by the Appliance Standards Awareness Project.

Factors effecting DTA standards options are unique for a number of reasons: 1) They are a new product for which very few domestic examples yet exist. 2) Because they may rarely be placed in standby mode, their on mode energy level is important. 3) Although their energy impact in California will be large, their impact in other countries such as China is expected to be huge, and therefore there is significant international interest in regulation (IEA 2004).

4.5 Energy savings

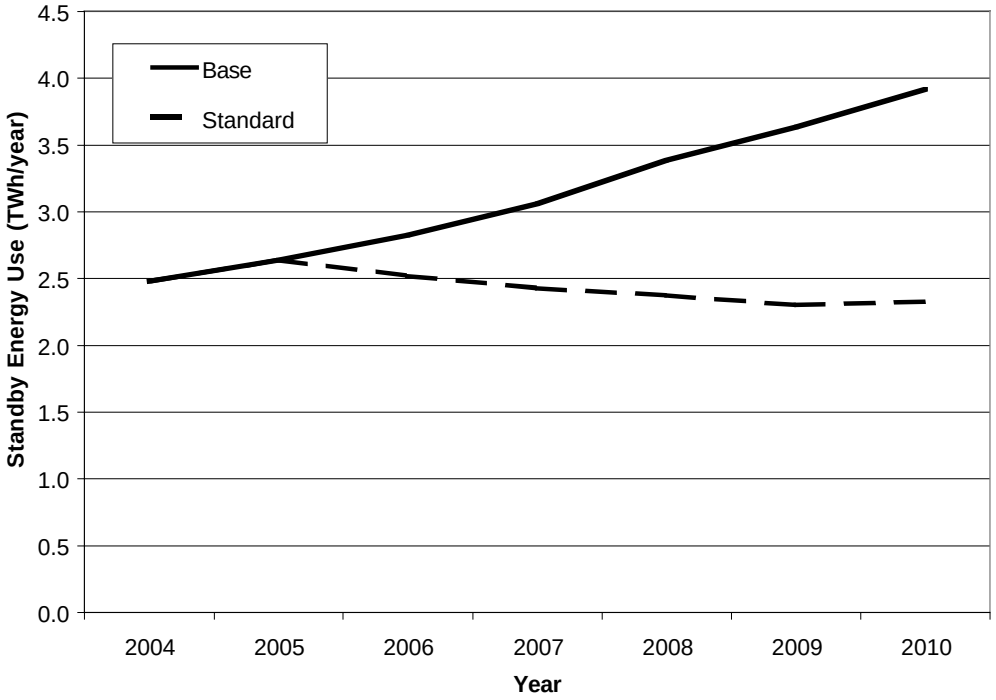
Table 7 summarizes the energy and demand savings if Energy Star Tier 1 standby power levels were implemented as a standard level in 2006 for all products except DTAs. Energy savings for DTAs are based on a level of 1W standby and 8W active that was proposed during the last International Energy Agency workshop on STBs (IEA 2004). By far the largest savings come from compact audio, TVs, and basic IRDs. While initial DTA savings are small, due to their small current stock, their potential savings are much larger. DVD savings are much more modest, mostly due to the large fraction that already meet Energy Star levels.

Figure 5 demonstrates the long-term effect of the standards on annual standby energy use. Without a mandated level, total use would rise to almost 4 TWh/year by 2010. With a standard level effective in 2006, the total use would drop by 2010 to less than the current level of 2.5 TWh/year. While the savings per unit are small, the number of products is huge. Annual utility present cost savings associated with this potential 1.5 TWh/year is $225 Million.

Table 7: Energy Savings

	Energy Savings (GWh/yr)		*Demand Savings (MW)*	
	First Year	*2010*	*First Year*	*2010*
Compact Audio	95.1	479.5	5.4	27.4
TV	88.8	448.6	5.1	25.6
DVD	7.9	46.5	0.5	2.7
Basic IRD	101.2	486.1	5.8	27.7
DTA	31.8	312.5	1.8	17.8
Total	306.5	1594.1	17.5	91.0

Figure 5: Effect of Standards on Annual Standby Energy Use



5 Economic Analysis

5.1 Incremental cost

Incremental costs for most of the standby energy efficiency measures are difficult to quantify, but are expected to be very low. Some products will be able to meet the standard levels by making one-time design decisions within the re-design cycle. Others will need new more efficient components or small design changes. On average, we expect costs to be less than $1 for DVDs, and compact audio, and DTAs, and less than $3 for TVs and basic IRDs.

5.2 Design life

Because of the rate of change in consumer electronics, products typically become obsolete long before they actually wear out. Some of these products end up being used as secondary or tertiary devices for use by guests and children so their hours of operation may be drastically different than the primary device. Design life estimates for some of the products are shown in Table 8. We feel these lives are all on the low side, providing for a conservative life cycle cost estimate.

Table 8: Design Life of Consumer Electronic Products

Product	*Design Life (years)*
Compact Audio	5
TV	7

DVD	5
Set-top box	4

Source: Appliance 2002

5.3 Life cycle cost

The life cycle cost for five categories of consumer electronics calculated using the standard California Energy Commission methodology is provided in Table 9. Present value of annual energy savings are interpolated from California Energy Commission 2000 Appliance Standards - Life Cycle Cost Analysis document Table 1A.

Table 9: Analysis of Customer Net Benefit

Option	*Design Life (years)*	*Annual Energy Savings (kWh)*	*Present Value of Energy Savings*[*]	*Incremental Cost*	*Customer Net Present Value*[**]
Compact Audio	5	51	$26	$1	$25
TV	7	27	$19	$3	$16
DVD	5	8	$5	$1	$4
Basic IRD	4	31	$14	$3	$11
DTA	4	73	$33	$10	$13

*Present value of energy savings calculated using a Life Cycle Cost of $0.50 - $0.86/kWh (CEC 2001).
**Positive value indicates a reduced total cost of ownership over the life of the appliance

6 Acceptance Issues

Consumer electronics are purchased by the consumer based on their feature set and price. Awareness of energy use is very low and often not one of the consumer's purchase criteria. In the case of many set-top boxes the consumer has no say in what product is used as these are typically leased from the service provider. Consumer electronic equipment is highly standardized at the national level, and sometimes even at the global level, with many manufacturers tending to be global players.

6.1 Infrastructure issues

The largest factor working both for and against a mandatory standard level is the very high rate of change in consumer electronics. This high rate of change makes it easy to incorporate design changes in new equipment, as design cycles can be one year or less. However, the rapid change in features and functions makes manufactures reticent to commit to fixed standard levels on equipment that may need to soon have new functions with unknown standby power implications. This second factor can be mitigated by keeping the standards to basic equipment, but this may have the unintended consequence of encouraging manufactures to add functionality in order to evade standards.

6.2 Existing standards

Standby power consumption in general has become more widely recognized since President Bush issued Executive Order 13221, which states; "Each agency, when it purchases commercially available, off-the-shelf products that use external standby power devices, or that contain an internal standby power function, shall purchase products that

use no more than one watt in their standby power consuming mode. If such products are not available, agencies shall purchase products with the lowest standby power wattage while in their standby power consuming mode. Agencies shall adhere to these requirements, when life-cycle cost-effective and practicable and where the relevant product's utility and performance are not compromised as a result" (Bush 2001). FEMP has been charged with organizing the testing and publication of standby power use for the various products. The current list includes office equipment, telephones and related equipment, TVs and VCRs, audio equipment, room air conditioners, clothes washers, dishwashers, microwaves, ceiling fans with remote controls, portable power tools, desktop halogen lamps, and exercise equipment (FEMP 2002).

Many of the products covered by DOE's efficiency standards use power in standby mode. Although standby power use has typically not been included in most test procedures, DOE is taking steps to incorporate it in all of its test procedures during the next revision cycle. However, there are currently no DOE standards that cover consumer electronics. Section 621 of the Energy Policy Act of 2003 (H.R 6), which did not pass, but may return this year, includes language requiring that DOE establish definitions and test procedures for the standby mode power use of battery chargers and external power supplies within 18 months and determine energy conservation standards within 3 years[5].

Standby power use has been the focus of many national and international programs and regulations, mostly voluntary, for over 10 years. The EPA Energy Star program got its start with sleep mode energy use in computer equipment and has been taking an active role in encouraging low standby power levels in a wide range of consumer electronics ever since. They are currently moving to a lower tier 2 level with the levels for STBs currently under review. In 1996, the EU introduced a voluntary agreement to significantly reduce standby consumption by TVs and VCRs. Australia has formally adopted a "one-watt plan" with the goal of reducing standby power consumption by individual products to one watt by 2012 and will be announcing mandatory efficiency standards for a range of consumer electronic equipment this October. In 2003 the European Commission issued its latest revision to the EU Code of Conduct for Digital TV Services (EC 2003), which sets maximum standby power consumption levels of set-top boxes and digital TVs (Bertoldi et al, 2002). Korea is the only country that currently has a mandated STB standby power level. Table 10 summarises the levels of various national programs.

Table 10: Summary of National Standby Power Programs

Country	Program	Product	Level (watts)
US	Energy Star (tier 1,2)	Analog TV	1,1
		Digital TV	3,1
		VCR	2,1
		Combinations	4,1
		Audio	2,1
		DVD	3,1
		TV with POD slot	15,*
		Analog STB	3,* (+5/LNB)

[5] http://thomas.loc.gov/cgi-bin/query/z?c108:S.14.PCS

		Digital STB	15,* (+5/LNB)
		Multifunction STB	20,* (+5/LNB)
	FEMP	TV	1
		VCR	2
		Combination	3
		Audio	2
EU	Eco-label	STB	9
		Analog TV	1
		Digital TV	10
		Audio	3
	Code of Conduct	STB (active,passive,off)	9,6,1
		TV	10 (6 avg)
		VCR	10 (6 avg)
		Audio (01,03,07)	5,3,1
Japan	Top-Runner	TV	formula
		VCR	1.7-2.5
Korea	Standard	STB	3
		Video Game	3
		Video Phone	3
		Multi-function STB	10
		DVR	10
		Multi-function	20

*Level currently being revised

7 Recommendations

7.1 Recommended Standards Options

The recommended standby power levels for the five categories of consumer electronics are shown in Table 11. All products should be restricted to those that are mains powered and use an internal power supply. Accurate and well defined definitions of the scope will be critical to implementing a good standard.

Table 11: Recommended Standard Level

Product	*Standby Level (watts)*	*On Level (watts)*
Compact Audio	2	N/A
TV	3	N/A
DVD	3	N/A
DTV Adapter	1	8
Basic IRD	15 + (5 x # of LNB)	N/A

There is currently little publicly funded research into STB energy efficiency strategies. In order to address the substantial energy savings still available in STBs, we also recommend that the Energy Commission encourage the development of energy saving

network protocols through coordinated research with service providers, manufacturers, and standards organizations.

7.2 Proposed Changes to the Title 20 Code Language

The following standards language is proposed for section 1605.3:

(v) **Audio and Video Equipment**. The standby power of audio and video equipment manufactured on or after January 1, 2006 shall not be more than the applicable values shown in Table X.

Table X
Standards for Audio and Video Equipment

Appliance	Maximum Standby Power (watts)	Maximum On Power (watts)
Compact Audio	2	N/A
Television	3	N/A
Digital Versatile Disc	3	N/A
Digital Television Adaptor	1	8
Basic Integrated Receiver Decoder	15 + (5 x # of LNB)	N/A

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